Mineral Inter-relationship among Soil, forage and Dairy cattle in Kashmir, India

M. S. Bhat, M. Shaheen, R. Zaman* and A. Muhee

Division of Clinical Veterinary Medicine, Ethics & Jurisprudence,
Faculty of Veterinary Sciences & Animal Husbandry,
Shere Kashmir University of Agricultural Sciences and Technology
Shuhama, Alsteng, Srinagar, Kashmir, India-190 006.
Received: 03-06-2011, Accepted:01-07-2011, Published Online: 23-10-2011
doi: 10.5455/vetworld.2011.550-553

Abstract

Samples of soil, forage and blood serum of cattle in six villages Ganderbal district of kashmir were collected and analysed for different macro and micro mineral contents to establish the mineral correlation among soil, forage and animals. The macro and micro mineral contents in soils of Ganderbal district were higher than their respective critical levels except Mn. Similarly, in forage except for zinc all the mineral values were above critical level. The study also revealed the serum mineral values above the critical levels. The soil and forage (r=0.558) and forage and serum (r=0.463) showed significant positive correlations while, non-significant ($P<0.05$) positive correlation (r=0.08) between soil and serum for Cu was observed. The correlation for Calcium, phosphorus, magnesium, zinc, iron and manganese observed between soil-forage, Forage-serum as well as soil-serum was non-sgnificant. Based on present study, supplementation of calcium, phosphorous, copper and zinc in the diet of cattle under existing feeding practices in Ganderbal district of Kashmir is imperative for better health and productivity. However, further, studies should elucidate the bioavailability and strategic dietary supplementation of minerals for livestock
Key words: Cattle, Forage, Mineral, Serum, Soil.

Introduction

There is a complex relationship between soil, plant and animal due to specific characteristics of the plants and interaction between different minerals. There appears to be a definitive role of mineral deficient soils to cause deficient levels in ration (Mc Dowell and Conrad, 1990). The livestock in the Alusteng region of Ganderbal district are mostly reared on crop residues, tree leaves and natural grasses. The livestock in this region has much lower production potential; under nutrition being major cause of depressed growth and reproductive in-efficiency. These animals generally do not receive mineral mixture supplementation in their basal diet. Thus livestock production is often badly influenced by mineral deficiencies and/or imbalances. In India where dietary concentrations of fodder fed to the animals are unknown or highly variable due to availability, season, location, forage, species and animal potentials (Sharma *et al*., 2003a), it is important to determine mineral concentrations in animals region-wise, to estimate needs of livestock so as to obtain optimum productivity and to assess the effect of mineral deficiencies on serum vitamins, hormones and enzyme profile. A limited information is available on the feeding practices and mineral status of feeds, fodder, soil and animals blood in Ganderbal district of Kashmir. Keeping this in view the present study was conducted in Ganderbal district of Kashmir valley to establish relationship for different minerals among soil, forage and animals in order to suggest dietary supplementation of area specific mineral mixture.

Materials and methods

The study was conducted in six villages of Ganderbal district of Kashmir. Minimum 8-10 farmers from each village were identified for the baseline survey. The Soil, forage and blood samples were collected, labeled and stored till further processing. Digestion of soil, forage and serum samples according to the methods as described by Association of Analytical Chemists (AOAC, 1990). The processed samples were use for estimation of minerals (Ca, Mg, Cu, Fe Zn and Mn) in the Division of Soil Sciences, SKUAST-K, Shalimar Srinagar, using Atomic Absorption Spectro-photometer (Model No. AAS 4141) manufactured by Electronics Corporation of India Limited (ECIL), Hyderabad, using Air acetylene flame. Phosphorous in soil and forage samples was estimated as per method given by Olsen *et al*. (1954) and in serum the Inorganic phosphorous (Pi) was determined using method given by Taussy and Shorr (1953) using spectrophotometer (Spectronic 20). The data on mineral contents were subjected to statistical analysis for mean, standard error, correlation coefficient and test of significance (Snedecor and Cochran, 1994).

Results and Discussion

Under Indian conditions the mineral deficiency diseases are quite common and are mainly due to non availability of balanced diet or deficiency of minerals in the soil and fodder. The levels of different minerals in the soil were above the critical concentration except for iron and manganese (Table-1).

Table-1. Status of soil minerals in Alusteng area of Ganderbal district

Mineral	Critical concentration*	Mean ± S.E	%samples below CC
Calcium (ppm)	71	131.25±0.98	0
Magnesium (ppm)	9.10	9.93±0.26	32.50
Phosphorous (ppm)	5	19.43±2.01	2.50
Copper (ppm)	1	1.57±0.14	27.50
Zinc (ppm)	1.50	1.79 ±0.19	60
Iron (ppm)	20	17.60±1.60	55
Mangenese (ppm)	5	4.41±0.43	65

* Critical concentration (McDowell *et al*., 1983)

Aref (2010) also reported soil iron concentration (1.5 ppm) below the critical concentration in Iran. Soil manganese levels below the critical levels have also been reported from Uttarakand (Shukla *et al.*, 2010) and subtropical hill ecosystem of Mizoram (Kumaresan *et al.*, 2010). Sharma *et al*. (2003b) reported 61 per cent zinc deficiency in Yamunanagar district of Haryana, which was in corroboration with the present findings (60%).

In the forage all the minerals were above the respective critical levels except for zinc (29.74 ±2.26) (Table 2). Sharma *et al.* (2003b) also reported forage zinc below the critical value in Karnal district of Haryana (26.62±0.34). Highest deficiency in the soil was observed for Zinc (57.5 %) and copper (50 %). Similar results were also obtained by Sharma *et al.* (2003b) in Ambala and Nabha district of Haryana, respectively. The availability of minerals depends on the concentration and chemical form of these elements in the soil. The availability of minerals in the soil depends upon the effective concentration in soil solution (Hoekstra, 1973), which is influenced by pH, moisture, organic matter, leaching, presence of other elements and microbial activity of soil (Burk, 1978; Williams, 1977). Thus in the present study high deficiency of copper and zinc and marginal deficiency of calcium can be attributed to various factors like increased crop and fodder productivity, variation in the pH, fertilization of soil and the availability of competing elements to the plant and the rate of plant growth.

Table-2. Status of forage minerals in Alusteng area of Ganderbal district

Mineral	Critical concentration*	Mean ± S.E	%samples below CC
Calcium (%)	0.30	0.51±0.02	10
Magnesium (%)	0.12	0.18±0.01	0
Phosphorous (%)	0.20	0.35±0.03	35
Copper (ppm)	10	17.18±2.15	50
Zinc (ppm)	30	29.74 ±2.26	57.50
Iron (ppm)	30	426.39±33.27	0
Mangenese (ppm)	40	77.99±10.12	27.50

* Critical concentration (McDowell *et al*., 1983)

The Mean ± S.E values of different minerals in the serum of dairy cattle are represented in Table-3. In the serum of the cattle highest deficiency was observed for copper (50%) followed by phosphorous and calcium (37.5 %). The findings are in agreement with Chhabra (2006) also reported 46.9 per cent copper deficiency in cattle. Ramana *et al.* (2000) reported 34 per cent Calcium deficiency prevalent in dairy animals of southern transition zone of Karnataka. Low serum levels of Ca, Pi and Cu was probably due to their low content in locally available feedstuffs and the drain of Calcium and Pi through lactation. There is a constant association of hypophosphatemia and hypocalcaemia with low dietary intake of phosphorous and calcium and the drain of lactation causes further depletion of phosphorous and calcium reserves (Radostits *et al.*, 2000). McDowell (1985) suggested that decreased gut absorption as well as increased excretion of copper in animals resulted in lower concentration of this mineral in serum.

Table-3. Status of serum minerals in dairy cattle of Alusteng area of Ganderbal district

Mineral	Normal Values*	Mean ± S.E	%samples below CC
Calcium (mmol/l)	>2	2.21±0.06	37.50
Magnesium (mmol/l)	>0.6	1.25±0.01	0.00
Phosphorous (mmol/l)	>1.5	1.80±0.01	37.50
Copper (µmol/l)	>9.6	11.78±1.29	50
Zinc (µmol/l)	>12.2	19.91±1.35	22.50
Iron (µmol/l)	>17.9	41.80±2.09	2.50
Manganese (µmol/l)	> 3.30	3.48±0.10	7.50

* Radostits *et al.*, 2000

The mineral inter-relationship among soil, plants and animals (Table 4), revealed that there was non-significant negative correlation for calcium between soil and forage and soil and serum, which might be due to excessive usage of nitrogen fertilizers that might have led to reduction in uptake of calcium

Table-4. Correlation between soil-forage-serum minerals

Mineral	Soil-forage	Soil-serum	Forage-serum
Calcium	-0.001	-0.220	0.017
Magnesium	0.065	0.076	-0.132
Phosphorous	-0.015	0.061	-0.231
Copper	0.558**	0.301	0.463**
Zinc	-0.125	-0.211	0.212
Iron	0.308	0.138	0.138
Manganese	-0.045	0.112	0.212

by plants (Underwood and Suttle, 1999). Calcium also revealed non-significant positive correlation between forage and serum. Magnesium showed non-significant negative correlation between forage and serum but non significant positive correlation between soil and forage and soil and serum. A non-significant positive correlation was observed between soil and serum while a non-significant negative correlation existed between forage and serum, soil and forage for phosphorous which led to mineral imbalances among soil, plants and animals for phosphorus (Kalita *et al.*, 2003) which may be attributed to unfavorable soil pH. There was a significant positive correlation between soil and forage and forage and serum while non-significant positive correlation between soil and serum for copper. The findings revealed that about 50 per cent of the forage samples were deficient in copper and was insufficient to meet the dietary requirement of animals leading to low copper concentration in blood serum. Jumba *et al.* (1995) also observed that a low level of copper in feeds was reflected in animals through their lower serum copper levels. For zinc a non-significant negative correlation was observed between soil and serum and soil and forage while non-significant positive correlation between forage and serum was observed.

This indicated that comparatively higher level of zinc in forage was reflected in serum. A non-significant positive correlation was found between soil and forage, forage and serum and soil and serum for iron, which showed the soil-plant-animal relationship for iron in this particular area. For manganese a non-significant negative correlation existed between soil and forage and a non-significant positive correlation between soil and serum and forage and serum.

These observations revealed that in nature, a definite cycle of nutrients transfer from soil to plants and from plants to animals and back to soil is maintained. Based on present study, supplementation of calcium, phosphorous, copper as well as zinc in the diet of cattle of Ganderbal district of Kashmir is imperative under existing feeding practices. However, further, studies could elucidate the bioavailability and strategic dietary supplementation of minerals for livestock.

Acknowledgements

This experiment was supported by the SKUAST-K post graduate programme research funds. We are grateful to various divisions of Faculty of Veterinary Sciences & Animal Husbandary, Shuhama, Srinagar, J&K, India and Division of Soil sciences, SKUAST-K. Shalimar for their timely support and cooperation.

References

1. Ahmad, J.W.M., El-Ekhnawy, K. I., EI-Nattat, W.S., EI-Razik, K.A.A. and EI-Khadraw, H.M. (2004): Investigations on calving associated problems in Friesian herd in Egypt with special reference to some prophylactic trials. *Egyptian J. Basic Appl. Physiol.* 3: 65-87.
2. AOAC. (1990): Official Methods of Analysis of the Association of Official Analytical Chemists, Vol. II, 15th ed. Sec.985.29. The Association: Arlington, VA.
3. Aref, F. (2010): Zinc and Boron Fertilization on Concentration and Uptake of Iron and Manganese in the Corn Grain. *Journal of American Science*, 6(8): 236-242.
4. Burk, R.F. (1978): Selenium in nutrition. *World Record on Nutrition Diet*, 30: 88-106.
5. Chhabra, S. (2006): 'Studies on mineral imbalances in dairy animals with special reference to copper, manganese and iodine status in Punjab'. Ph.D. dissertation. Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab.
6. Hoekstra, S.L. (1973): Biochemical role of Selenium, In: Trace Element Metabolism in Animals-2. Pp. 61-77. Baltmore: University Park Press.
7. Jumba, T.O., Suttle, N.F., Hunter, E.A. and Wandiga, S.O. (1995): Effects of soil origin and mineral composition and herbage species on the mineral composition of forages in the Mount Flagon region of Kenya. 2. Trace elements. Tropical Grasslands, 29: 47-52.
8. Kalita, D.J., Sarmah, B.C., Sarmah, D.N. and Mili, D.C. (2003). Mineral status and their retention in lactating cows in relation to soil, fodder and feed in Kamrup district of Assam. Indian Journal of Animal Nutrition, 20: 421-429.
9. Kumaresan, A., Bujarbaruah, K.M., Pathak, K.A. and Brajendra, T. (2010): Soil-plant-animal Continuum in Relation to Macro and Micro Mineral Status of Dairy Cattle in Subtropical Hill Agro Ecosystem. *Tropical Animal Health and Production*, 42(4): 569-577.
10. McDowell, L.R., J.H. Conrad, G.L. Ellis and L.K. Loosli. (1983). Minerals for Grazing Ruminants in Tropical Regions. *Extension Bulletin 1149* (Animal Science Department, University of Florida: Gainseville.).
11. McDowell, L.R. (1985): In: *Nutrition of Grazing Ruminants in Warm Climates.* Academic Press, New York. pp. 443.
12. McDowell, L.R., and Conrad J.H. (1990): Mineral imbalances of grazing livestock in tropical countries. *International Journal of Animal Sciences*, 5: 21-32.
13. McDowell, L.R., Conard, J.H. and Hemby, G.F. (1993). Minerals for grazing ruminants in tropical regions. Animal Science department, Centre for tropical agriculture, University of Florida. The U.S. Agency for International Development and Carribean Basin Advisory Group (CBAG)
14. Olsen, S.R., C.V. Cole, F.S. Watanabe and L.A. Dean. (1954): Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dept. of Agric.

Circ. 939.

15. Radostits, O.M., D.C. Blood, C.C. Gay, D.C. Blood and K.W. Hinchkliff. (2000): *Veterinary Medicine*. 9th edn. ELBS-Bailliere Tndal, London .
16. Ramana, J.V., Prasad, C.S. and Gowda, S.K. (2000): Mineral profile of soil, feeds, fodders and blood plasma in southern transition zone of Karnataka. *Indian Journal of Animal Nutrition*, 17: 179-83.
17. Sharma, M.C., Joshi, C., Gupta, S., Joshi, C. and Gupta, S. (2003a): Prevalence of mineral deficiency in soil, plants and cattle of certain districts of Uttar Pradesh. *Indian Journal of Veterinary Medicine*, 23: 4-8.
18. Sharma, M.C., Raju, H.S., Joshi, C., Kaur, H. and Varshney, V.P. (2003b): Studies on serum micro mineral, hormone and vitamin profile in buffalo, its effect on production and therapeutic management in Haryana state of India. *Asian Austra. Journal of Animal Sciences*, 6(4): 519-528.
19. Shukla, S., Tiwari, D.P., Mondal, B.C. and Kumar, A. (2010): Mineral interrelationship among soil, plants and animals in Pithoragarh district of Uttarakhand. *Animal Nutrition and Feed Technology*, 10: 127-132.
20. Snedecor, G.W. and Cochran, W.G. (1994): Statistical Methods, 8th ed. Oxford and IBH Publishing Co. Calcutta, India.
21. Taussy, H. H. and Shorr, E. (1953): A micro colorimetric method for determination of inorganic phosphorus. *J Biol Chem*. 202: 675-85.
22. Underwood, E.J. and Suttle, N.F. (1999): *The Mineral Nutrition of Livestock*, 3rd Edn. CABI Publishing, New York.
23. Williams, C.H. (1977): Trace metals and superphosphates: Toxicity problems. *Journal of Australian Institute of Agriculture Science*, 43: 99-109.

* * * * * * * *